



(11) **EP 2 871 336 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
08.08.2018 Bulletin 2018/32

(51) Int Cl.:
F01K 13/02 ^(2006.01) **F22B 35/00** ^(2006.01)
F22B 37/22 ^(2006.01)

(21) Application number: **13191735.3**

(22) Date of filing: **06.11.2013**

(54) **Method for managing a shut down of a boiler**

Verfahren zur Abschaltung eines Kessels

Procédé de l'arrêt d'une chaudière

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(43) Date of publication of application:
13.05.2015 Bulletin 2015/20

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a method for managing a shut down of a boiler.

EP 1 154 127 A2 describes a method to preheat or keep warm some components of a steam power plant before starting it.

BACKGROUND

[0002] Figure 1 shows an example of a boiler 1 having an evaporator 2 defined by walls 3 (tubed walls, preferably finned tubed wall); the walls 3 define a chamber 4 and the bottom of the walls 3 defines a hopper 5.

[0003] One or also more than one walls 3 carry a firing system 6 comprising a fan for an oxidizer like air and a fuel supply 8 for coal, oil, gas, etc.

[0004] The tubed walls 3 are connected to inlet headers 9 and outlet headers 10; water is collected at the inlet headers 9 and is distributed through the tubes of the tubed walls 3 and, after passing through the tubed walls 3, steam (or a mixture of steam and water or steam containing some water to a low extent) is collected at the outer headers 10. The headers 9 and 10 are outside of the chamber 4. Naturally also other types of evaporators are possible.

[0005] Above the evaporator 2, the boiler 1 has a duct 12 that houses in series, from the bottom to the top, a superheater 13 for heating the steam directed to a high pressure user (like for example a high pressure turbine 13a of a power plant) and a reheater 14 for heating the steam discharged from the high pressure user and directed to a medium or low pressure user (like for example a medium or low pressure turbine 14a of a power plant).

[0006] The superheater 13 includes heat exchanging components having tubed heat exchanging surfaces 16 connected to inlet headers 17 and outlet headers 18; for example the tubed heat exchanging surfaces 16 can be tubed coils or tubed panels.

[0007] The attached figure shows an example of a superheater 13 including three heat exchanging components each having tubed heat exchanging surfaces 16, inlet header 17 and outlet header 18.

[0008] The reheater 14 has a structure similar to the structure of the superheater 13.

[0009] The reheater 14 includes heat exchanging components that comprise tubed heat exchanging surfaces 16, such as tubed coils or tubed panels. The tubed heat exchanging surfaces 16 are connected to inlet headers 17 and outlet headers 18.

[0010] The attached figure shows an example of a reheater 14 including two heat exchanging components each having tubed heat exchanging surfaces 16, inlet header 17 and outlet header 18.

[0011] Above the reheater 14 there is provided an economizer 20, to pre-heat water coming from a feed-

water source 20a and directed to the evaporator 2. The economizer 20 is also provided with inlet headers and outlet headers.

[0012] In the duct 12, downstream the economizer 20, there are typically installed a catalyzer 21 (if needed according to the emission requirements) for reducing the NO_x content of the flue gas, a preheater 22 for preheating air that is supplied into the chamber 4 for combustion of the fuel, a dust removal unit 23 such as a filter or electrostatic precipitator for solid particles removal from the flue gas; in some cases a damper 24 for regulating the opening of the flue gas duct 12 and a fan 7 for transportation of the flue gas to the stack 34 can also be provided.

[0013] In some cases, the economiser 20 can be separated in two parts, one upstream the catalyzer 21 and one downstream the catalyzer 21.

[0014] During operation, water passes through the economizer 20 where it starts heating and then it is supplied through the headers 9 to the tubed walls 3. While passing through the tubed walls 3 water evaporates, generating steam that is collected at the headers 10 and is directed (through a separating system 25 to remove possible liquid droplets) to the super heater 13 via the headers 18a. The first stage of the super heater 13 can either be the upper (vertical) boiler enclosure wall or the internal hanger tubes ending in the first super heater bundle.

[0015] Downstream of the superheater 13, superheated steam is directed to the high pressure turbine 13a for example of a power plant or for other high pressure user or to the reheater 14 inlet via the high pressure bypass valve 26.

[0016] Steam from the high pressure turbine 13a or other high pressure user is collected at the inlet header 17 of the reheater 14 and, after passing through the reheater 14 it is collected in the outlet header 18 from which it is directed to the medium or low pressure turbine 14a or medium or low pressure user or via the low pressure bypass valve 27 to the condenser 35 provided downstream of the steam turbine.

[0017] Liquid droplets collected at the separating system 25 are directed back through the recirculation pump 29 to the economizer 20.

[0018] During shut down the firing system 6 is stopped, the high pressure turbine 13a and the medium or low pressure turbine 14a are disconnected and the valves 26 and 27 are closed.

[0019] For this reason, the steam passing through the superheater 13 and reheater 14 is stopped, i.e. there is no further steam flow within the heating surfaces 16 of the superheater 13 and the reheater 14.

[0020] Nevertheless, during shut down air keep circulating through the chamber 4, this is due for example to purging or natural draft. For example, often the fan 7 operates for maintaining an underpressure inside the boiler enclosure also during shut down. This causes an air flow at temperature lower than the temperature of the steam within the superheater 13 and reheater 14.

[0021] The flow increases the cooling of the steam con-

tained within the tubed heat exchanging surfaces 16 of the superheater 13 and reheater 14. This cooling can be large, because the thickness of the surfaces of the tubed heat exchanging surfaces 16 is usually small, such that the thermal storage capacity of the tube walls is low.

[0022] In contrast, the steam contained within the headers 17, 18 only undergoes a very limited cooling.

[0023] In fact, the headers 17, 18 have a large wall thickness and therefore they also have a large thermal storage capacity.

[0024] In addition, the headers 17, 18 are insulated such that substantial cooling from the outside of the headers 17, 18 is prevented; moreover, since there is no steam flow inside the headers 17, 18, no substantial cooling from the inside of the headers 17, 18 occurs.

[0025] As a consequence, the temperature of the steam and of the header 17, 18 of the reheater 14 and superheater 13 (i.e. of the material of the header 17, 18) will decrease only with a very small gradient (i.e. the temperature of this steam slowly decreases), but the temperature of the steam contained in the tubed heat exchanging surfaces 16 of the reheater 14 and superheater 13 sensibly drops.

[0026] When the boiler 1 is start up again after shut down, the firing system 6 is started and the high pressure bypass valve 26 and the low pressure bypass valve 27 are opened.

[0027] Opening the high pressure bypass valve 26 and the low pressure bypass valve 27 causes steam circulation through the tubed heat exchanging surfaces 16 and the headers 17, 18 of the superheater 13 and the reheater 14. This circulation causes steam at a low temperature (because it was contained within the tubed heat exchanging surfaces 16 during shut down) to pass through the headers 17, 18 that have a much higher temperature.

[0028] This circulation thus causes thermal stress of the material of the header 17, 18 and possibly a reduction of the lifetime.

SUMMARY

[0029] An aspect of the disclosure includes providing a method by which the thermal stress of the headers of the superheater and/or reheater can be limited. This is achieved by the subject matter as defined in the independent claim.

[0030] These and further aspects are attained by providing a method in accordance with the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Further characteristics and advantages will be more apparent from the description of a preferred but non-exclusive embodiment of the method, described with reference to the non-limiting accompanying drawings, in which:

Figure 1 is a schematic view of a boiler.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0032] In the following reference to the boiler of figure 1 is made.

[0033] The method can be applied to any boiler also different from the one shown. For example the walls 3 can extend up to the top of the boiler (i.e. they can define the duct 12 and house the tubed coils or tubed panels 16). The walls can either be completely used as evaporator or can be divided in evaporator (lower part) and superheater (upper part). In addition the evaporator can have a different structure than the tubed walls 3.

[0034] The method is preferably implemented to limit the stress of the headers 17, 18 of the superheater 13, but it can also be conveniently used to limit the stress to the headers 17, 18 of the reheaters 14 or of other parts of the boiler 1.

[0035] The method comprises regulating the temperature of the headers 17, 18 during shut down to a target temperature that is a function of the expected temperature for the steam moving from the tubed heat exchanging surfaces 16 into the headers 17, 18 at a starting up following the shut down. The target temperature is for example the expected temperature for the steam moving from the tubed heat exchanging surfaces 16 into the headers 17, 18 or a temperature preferably close to this expected temperature and in this last case the temperature is lower than the expected temperature.

[0036] In particular this temperature regulation is a cooling of the headers 17, 18.

[0037] This cooling is mainly done after shut down, that means without additional use of expensive fuel, only by using the boiler pressure storage capacity and the boiler heat content in an appropriate way.

[0038] Thanks to this controlled cooling of the headers 17, 18, when the boiler 1 is started up after shut down, the steam moves from the tubed heat exchanging surfaces 16 through the the headers 17, 18 and since the temperature of the steam does not differ from the temperature of the headers 17, 18 or the difference is a limited controlled and calculated difference, the thermal stress undergone by the headers 17, 18 is limited. Regulating the temperature of the headers 17, 18 comprises maintaining a flow through the headers 17, 18 during the shut down or at least part of the shut down.

[0039] In fact, by steam keeping circulating through the tubed heat exchanging surfaces 16 and headers 17, 18, the headers 17, 18 are cooled by the steam that circulates through them and that is in turn cooled by the flow through the duct 12.

[0040] Maintaining the flow through the headers 17, 18 can be implemented by maintaining a steam flow through the control valve 26 and valve 27. In fact, the flow through the valve 26 allows cooling of the headers 17, 18 of the superheater 13 and the flow through the valve 27 allows to cool the headers 17, 18 of the reheater 14. Preferably the mass flow through the valve 26 and 27 is less than

10% of the nominal mass flow.

[0041] In a preferred embodiment, the method is implemented in connection with the tubed heat exchanging surfaces 16 of the superheater 13 and the control valve 26 is downstream of the superheater 13.

[0042] In addition, a gas flow is preferably maintained through the duct 12 during shut down. Maintaining a gas flow through the duct 12 includes operating the fan 7. For example the fan 7 is operated at minimum load or at a load less than 10% of its nominal mass flow. Operating the fan 7 is anyhow not mandatory and natural draft can suffice for air circulation.

[0043] The method can also comprise regulating the pressure within the boiler, i.e. within the heat exchanging components; pressure regulation can be done before shut down or during shut down. Preferably such a regulation aims at increasing the pressure within the boiler 1.

[0044] In a first example, regulating the pressure includes regulating the high pressure by-pass control valve 26 or the turbine inlet valve.

[0045] In a different example, regulating the pressure includes circulating water through the economizer 20 and evaporating at least partly water passing through the economizer 20. Circulation through the economizer 20 can be achieved by stopping the recirculation pump 29 and opening the line 30 (eco steaming line) provided between the top level of the economiser and the separating system 25.

[0046] Continuously operating the fan 7 for a certain time after shut down or using the natural boiler draft causes a permanent heat input on the economiser surfaces with steam production. This steam production is used to improve the pressure maintenance during the header cooling process. Maintaining a small feedwater flow (continuous or discontinuous) avoids a complete steaming of the economiser.

[0047] Naturally the features described may be independently provided from one another.

[0048] In practice the materials used and the dimensions can be chosen according to requirements and to the state of the art.

REFERENCE NUMBERS

[0049]

- | | | |
|----|---------------|--|
| 1 | boiler | |
| 2 | evaporator | |
| 3 | walls | |
| 4 | chamber | |
| 5 | hopper | |
| 6 | firing system | |
| 7 | fan | |
| 8 | fuel supply | |
| 9 | headers | |
| 10 | headers | |
| 12 | duct | |
| 13 | superheater | |

- | | | |
|---------|------------------------------------|--|
| 13a | high pressure turbine | |
| 14 | reheater | |
| 14a | medium/low pressure turbine | |
| 16 | tubed heat exchanging surfaces | |
| 5 17 | headers | |
| 18, 18a | headers | |
| 20 | economizer | |
| 20a | feedwater source | |
| 21 | catalyzer | |
| 10 22 | pre-heater | |
| 23 | dust removal unit | |
| 24 | damper | |
| 25 | separating system | |
| 26 | high pressure bypass control valve | |
| 15 27 | low pressure bypass valve | |
| 29 | recirculation pump | |
| 30 | eco steaming line | |
| 34 | stack | |
| 35 | condenser | |

Claims

1. A method for managing a shut down of a boiler (1), wherein the boiler (1) includes:

a duct (12),
at least a heat exchanging component, wherein the at least a heat exchanging component includes:

tubed heat exchanging surfaces (16) within the duct (12),
headers (17, 18) outside the duct (12),
the headers (17, 18) being connected to the tubed heat exchanging surfaces (16),
the headers (17, 18) and the tubed heat exchanging surfaces (16) containing steam,
the method comprising the step of regulating the temperature of the headers (17, 18) during shut down to a target temperature that is a function of the expected temperature for the steam moving from the tubed heat exchanging surfaces (16) into the headers (17, 18) at a starting up following the shut down, wherein regulating the temperature of the headers (17, 18) includes maintaining a steam flow through the headers (17, 18) after shut down of the firing system by maintaining a steam circulation from the tubed heat exchange surfaces connected to the respective headers and through said headers.

2. The method according to claim 1, wherein the boiler (1) further comprises a high pressure bypass control valve (26) downstream of the at least a heat exchanging component, **characterised in that main-**

taining a flow through the headers (17, 18) includes maintaining a steam flow through the high pressure bypass control valve (26).

3. The method according to claim 2, **characterised in that** the heat exchanging component is a superheater and the high pressure bypass control valve (26) is downstream of the superheater. 5
4. The method according to claim 1, **characterised by** maintaining a gas flow within the duct (12) during shut down. 10
5. The method according to the preceding claim, wherein the boiler (1) includes a fan (7) for gas circulation through the duct (12), **characterised in that** maintaining a gas flow includes operating the fan (7) . 15
6. The method according to the preceding claim, **characterised in that** operating the fan (7) includes operating the fan (7) at minimum load. 20
7. The method according to the preceding claim, **characterised in that** operating the fan (7) includes operating the fan (7) at less than 10% of its nominal mass flow. 25
8. The method according to claim 1, **characterised by** regulating the pressure within the boiler during shut down or before shut down. 30
9. The method according to the preceding claim, wherein the boiler (1) further comprises one or more high pressure bypass control valves (26) downstream of the superheater (13) and/or one or more low pressure by-pass control valves (27) downstream of the reheater (14), **characterised in that** regulating the pressure includes regulating the high pressure bypass control valves (26) and/or the low pressure by-pass control valves (27). 35 40
10. The method according to any of the two preceding claims, wherein the boiler (1) further comprises an economizer (20), **characterised in that** regulating the pressure includes circulating water through the economizer (20) and evaporating at least partly water passing through the economizer (20). 45
11. The method according to the preceding claim, **characterised in that** regulating the pressure further includes circulating air through the duct (12). 50
12. The method according to the preceding claim, wherein the boiler (1) includes a fan (7) for gas circulation through the duct (12), **characterised in that** circulating air includes operating the fan (7). 55

13. The method according to claim 1, **characterised in that** the target temperature is the expected temperature for the steam moving from the tubed heat exchanging surfaces (16) into the headers (17, 18) or a temperature lower than the expected temperature.

Patentansprüche

1. Verfahren zur Abschaltung eines Kessels (1), wobei der Kessel (1) das Folgende aufweist:

einen Kanal (12),
mindestens eine Wärmeaustauschkomponente,
wobei die mindestens eine Wärmeaustauschkomponente das Folgende aufweist:

mit Schläuchen versehene Wärmeaustauschflächen (16) innerhalb des Kanals (12),
Sammler (17, 18) außerhalb des Kanals (12),
wobei die Sammler (17, 18) mit den mit Schläuchen versehenen Wärmeaustauschflächen (16) verbunden sind,
wobei die Sammler (17, 18) und die mit Schläuchen versehenen Wärmeaustauschflächen (16) Dampf enthalten,

wobei das Verfahren den Schritt der Herunterregulierung der Temperatur der Sammler (17, 18) während der Abschaltung auf eine Zieltemperatur, die von der erwarteten Temperatur für den Dampf, der sich von den mit Schläuchen versehenen Wärmeaustauschflächen (16) in die Sammler (17, 18) bei Hochfahren nach der Abschaltung bewegt, abhängig ist, umfasst, wobei die Regulierung der Temperatur der Sammler (17, 18) die Aufrechterhaltung einer Dampfströmung durch die Sammler (17, 18) nach der Abschaltung des Feuerungssystems durch Aufrechterhaltung einer Dampfzirkulation von den mit Schläuchen versehenen Wärmeaustauschflächen, die mit den jeweiligen Sammlern verbunden sind, und durch die Sammler umfasst.

2. Verfahren nach Anspruch 1, wobei der Kessel (1) ferner ein Hochdruck-Bypass-Regelventil (26) stromabwärts von der mindestens einen Wärmeaustauschkomponente umfasst, **dadurch gekennzeichnet, dass** die Aufrechterhaltung einer Strömung durch die Sammler (17, 18) die Aufrechterhaltung einer Dampfströmung durch das Hochdruck-Bypass-Regelventil (26) umfasst.
3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** die Wärmeaustauschkomponente

ein Überhitzer ist und dass das Hochdruck-Bypass-Regelventil (26) stromabwärts vom Überhitzer angeordnet ist.

4. Verfahren nach Anspruch 1, **gekennzeichnet durch** die Aufrechterhaltung einer Gasströmung innerhalb des Kanals (12) während der Abschaltung. 5
5. Verfahren nach einem der vorhergehenden Ansprüche, wobei der Kessel (1) ein Gebläse (7) für eine Gaszirkulation durch den Kanal (12) aufweist, **dadurch gekennzeichnet, dass** die Aufrechterhaltung einer Gasströmung die Bedienung des Gebläses (7) umfasst. 10
6. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Bedienung des Gebläses (7) die Bedienung des Gebläses (7) bei minimaler Belastung umfasst. 15
7. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Bedienung des Gebläses (7) die Bedienung des Gebläses (7) bei weniger als 10% seines nominalen Massendurchsatzes umfasst. 20
8. Verfahren nach Anspruch 1, **gekennzeichnet durch** die Regulierung des Drucks innerhalb des Kessels während der Abschaltung oder vor der Abschaltung. 25
9. Verfahren nach einem der vorhergehenden Ansprüche, wobei der Kessel (1) ferner ein oder mehrere Hochdruck-Bypass-Regelventile (26) stromabwärts vom Überhitzer (13) und/oder ein oder mehrere Niederdruck-Bypass-Regelventile (27) stromabwärts vom Wiedererhitzer (14) umfasst, **dadurch gekennzeichnet, dass** die Regulierung des Drucks die Regulierung der Hochdruck-Bypass-Regelventile (26) und/oder der Niederdruck-Bypass-Regelventile (27) umfasst. 30
10. Verfahren nach einem der zwei vorhergehenden Ansprüche, wobei der Kessel (1) ferner einen Vorwärmer (20) umfasst, **dadurch gekennzeichnet, dass** die Regulierung des Drucks die Zirkulation von Wasser durch den Vorwärmer (20) und die mindestens teilweise Verdunstung von durch den Vorwärmer (20) fließendem Wasser umfasst. 35
11. Verfahren nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** die Regulierung des Drucks ferner die Zirkulation von Luft durch den Kanal (12) umfasst. 40
12. Verfahren nach dem vorhergehenden Anspruch, wobei der Kessel (1) ein Gebläse (7) für die Gaszirkulation durch den Kanal (12) aufweist, **dadurch ge-** 45

kennzeichnet, dass die Zirkulation von Luft die Bedienung des Gebläses (7) umfasst.

13. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Zieltemperatur die erwartete Temperatur für den Dampf, der sich von den mit Schläuchen versehenen Wärmeaustauschflächen (16) in die Sammler (17, 18) bewegt, oder eine Temperatur unter der erwarteten Temperatur ist. 50

Revendications

1. Procédé de gestion de l'arrêt d'une chaudière (1), dans lequel la chaudière (1) comprend: 55

un conduit (12),
au moins un composant d'échange de chaleur, dans lequel ledit au moins un composant d'échange de chaleur comprend:

des surfaces échangeuses de chaleur à tubes (16) à l'intérieur du conduit (12),
des collecteurs (17, 18) à l'extérieur du conduit (12),
les collecteurs (17, 18) étant connectés aux surfaces échangeuses de chaleur à tubes (16),
les collecteurs (17, 18) et les surfaces échangeuses de chaleur à tubes (16) contenant de la vapeur,

le procédé comprenant l'étape de régulation de la température des collecteurs (17, 18) pendant un arrêt à une température cible qui est une fonction de la température attendue pour la vapeur qui se déplace à partir des surfaces échangeuses de chaleur à tubes (16) dans les collecteurs (17, 18) lors d'un démarrage qui suit l'arrêt, dans lequel la régulation de la température des collecteurs (17, 18) comprend le maintien d'un écoulement de vapeur à travers les collecteurs (17, 18) après l'arrêt du système d'allumage en maintenant une circulation de vapeur à partir des surfaces d'échange de chaleur tubées jusqu'aux collecteurs respectifs et à travers lesdits collecteurs. 60

2. Procédé selon la revendication 1, dans lequel la chaudière (1) comprend en outre une soupape de commande de dérivation à haute pression (26) en aval dudit au moins un composant d'échange de chaleur, **caractérisé en ce que** le maintien d'un écoulement à travers les collecteurs (17, 18) comprend le maintien d'un écoulement de vapeur à travers la soupape de commande de dérivation à haute pression (26). 65

3. Procédé selon la revendication 2, **caractérisé en ce que** le composant d'échange de chaleur est un surchauffeur et la soupape de commande de dérivation à haute pression (26) est en aval du surchauffeur.
4. Procédé selon la revendication 1, **caractérisé par** le maintien d'un écoulement de gaz à l'intérieur du conduit (12) pendant l'arrêt.
5. Procédé selon la revendication précédente, dans lequel la chaudière (1) comprend un ventilateur (7) pour établir une circulation de gaz à travers le conduit (12), **caractérisé en ce que** le maintien d'un écoulement de gaz comprend l'actionnement du ventilateur (7).
6. Procédé selon la revendication précédente, **caractérisé en ce que** l'actionnement du ventilateur (7) comprend l'actionnement du ventilateur (7) à une charge minimum.
7. Procédé selon la revendication précédente, **caractérisé en ce que** l'actionnement du ventilateur (7) comprend l'actionnement du ventilateur (7) à moins de 10 % de son débit massique nominal.
8. Procédé selon la revendication 1, **caractérisé par** une régulation de la pression à l'intérieur de la chaudière pendant l'arrêt ou avant l'arrêt.
9. Procédé selon la revendication précédente, dans lequel la chaudière (1) comprend en outre une ou plusieurs soupape(s) de commande de dérivation à haute pression (26) en aval du surchauffeur (13) et/ou une ou plusieurs soupapes de commande de dérivation à basse pression (27) en aval du réchauffeur (14), **caractérisé en ce que** la régulation de la pression comprend la régulation des soupapes de commande de dérivation à haute pression (26) et/ou des soupapes de commande de dérivation à basse pression (27).
10. Procédé selon l'une quelconque des revendications précédentes, dans lequel la chaudière (1) comprend en outre un économiseur (20), **caractérisé en ce que** la régulation de la pression comprend la mise en circulation d'eau à travers l'économiseur (20) et l'évaporation au moins partiellement de l'eau qui passe à travers l'économiseur (20).
11. Procédé selon la revendication précédente, **caractérisé en ce que** la régulation de la pression comprend en outre la mise en circulation d'air à travers le conduit (12).
12. Procédé selon la revendication précédente, dans lequel la chaudière (1) comprend un ventilateur (7) pour établir une circulation de gaz à travers le conduit (12), **caractérisé en ce que** la mise en circulation de l'air comprend l'actionnement du ventilateur (7).
13. Procédé selon la revendication 1, **caractérisé en ce que** la température cible est la température attendue pour la vapeur qui se déplace à partir des surfaces échangeuses de chaleur à tubes (16) dans les collecteurs (17, 18) ou une température inférieure à la température attendue.

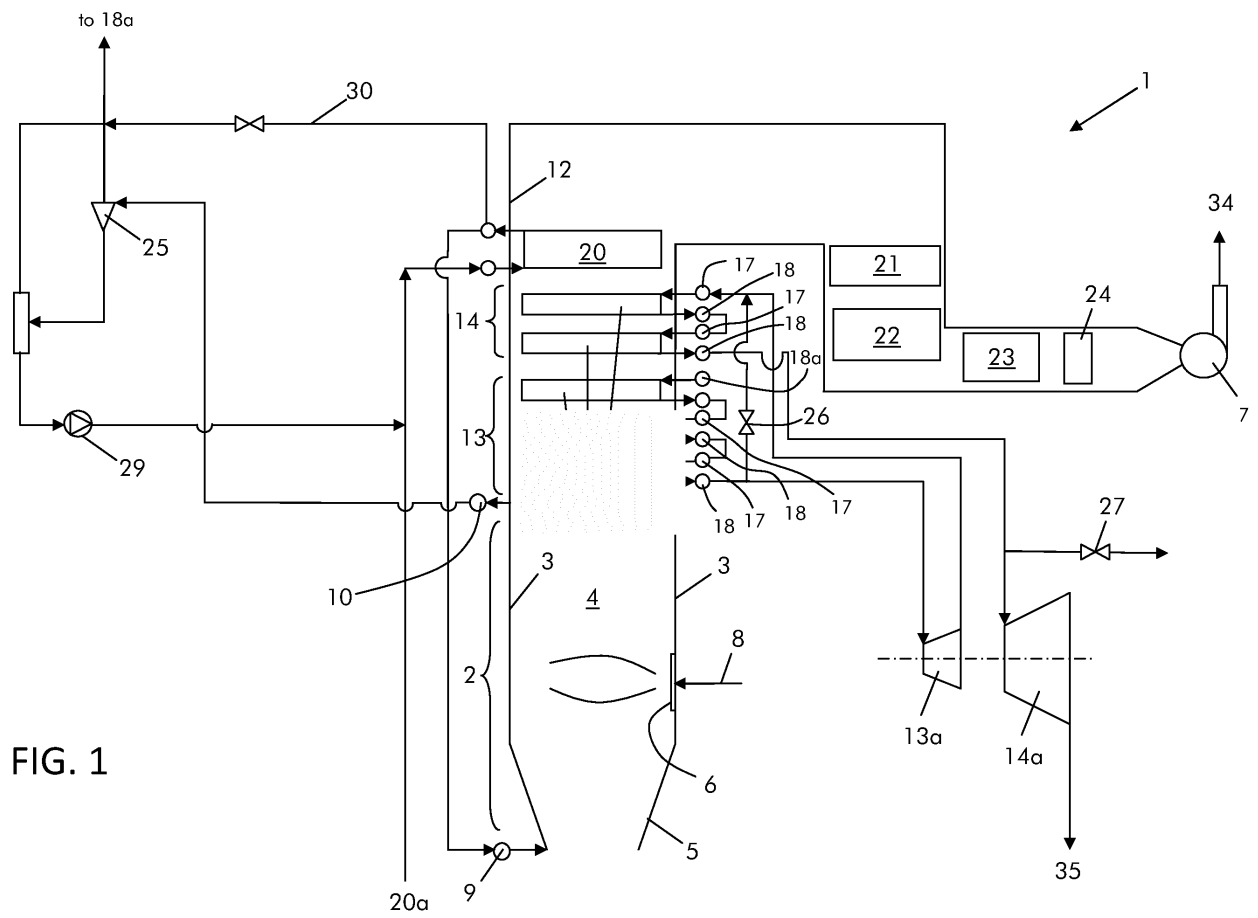


FIG. 1

REFERENCES CITED IN THE DESCRIPTION

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